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ABSTRACT

The paper reports on the application of a computer local area network and software to develop both literacy skills and science content knowledge in 15 deaf students. The network approach allows for interaction between a large number of students and the teacher both within and outside the context of the lesson and utilizes support programs to allow students to participate in group exercises. The network was used with an earth science instructional program which requires extensive reading and writing as students communicate with each other and the teacher and as they complete the instructional tasks. Preliminary evaluation indicates increased student time on literacy activities. Analysis of electronic mail messages and instructional responses allowed teachers to obtain more reliable information about student instructional needs. Includes four references. (DB)

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What is the meaning of...." Finding Links Between Science and Literacy Development in Deaf Children"

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BACKGROUND

Some 23 million Americans are functionally illiterate, lacking basic skills beyond a fourth grade level (Gamarekian, 1989). Teaching successful acquisition of literacy skills is a problem that all educators face constantly. In using the word "literacy" here we mean fluency in reading and writing English. This is an ancient and stubborn problem for members of the deaf and hearing-impaired population. Over-quoted statistics on the reading scores in the deaf and hearing impaired continue to be a source of concern for all involved. In addition to the problems in literacy, there is currently a renewed awareness of an overwhelming problem in low science achievement in elementary and secondary education. These two general problems, poor literacy and science achievement, are evident in the hearing population as well (NCEE, 1983). We decided to address both problems by immersing deaf students in a print environment through a relatively new technology, a system of linked computers in a local-area-network.

At the Lexington School for the Deaf, we used a system that had been developed by the Center for Children and Technology at the Bank Street College of Education. They developed and tested a computer network and software to aid in the teaching of Earth Science in inner-city schools (Newman, 1987). We decided to test the system at Lexington

Eight Apple IIGS computers were linked via a CORVUS local-area-network. These computers were located in a classroom that was separate from the regular science classrooms. They were arranged in a open-ended rectangle.

Two science teachers, the school's computer coordinator, and research staff from the Lexington Center, Bank Street College, and New York University participated in the project. Fifteen students participated in the earth science program and an additional 10 students used the Network to study biology. We are reporting only on the results of the earth science program which includes units on weather, rocks and minerals, and plate tectonics.

The Student Population

All fifteen students had a profound hearing loss in excess of 80dB. The etiology of the hearing loss for these children included genetic (7), unknown (5), menigitis (1), premature birth (1), and rubella (1). Of the students whose deafness was genetic, six had deaf parents, the remainder had hearing parents.

They do not hear closing doors, footsteps or sounds in the normal speech range. Many events must come into awareness through the visual channel. This technology allows relevant lesson information from the teacher to be presented and retrieved as the students need it, easing students' demands on memory and visual attention. The technology also made possible complete immersion in written English while presenting an earth science curriculum.

A Brief Description of the Network

The computer system installed at Lexington School for the Deaf was an interactive Local-Area Network. It is important to describe the differences between the interactive network that we used and Computer Aided Instruction. Computer Aided Instruction involves an interaction between a student and a single computer software program in a prescribed lesson. The goal is a pre-stated skill which the students can acquire and practice without the aid of a teacher. Local-area-network technology, while supporting the ability to be used for computer aided instruction, allows for interaction between a large number of students and the teacher inside and outside the context of the lesson. The teacher can act both as a guide and monitor. In addition, the network can support educational programs which allow students to participate in group exercises. By using a shared database, for example, students can separately contribute information to a data structure which they can organize and use. A shared text-editor allows the students to communicate in print to the teachers and each other for all of the purposes which language communication serves in any classroom.

The software available for student use included the Bank Street Writer and Bank Street Filer. The Filer was used in compiling and sorting large amounts of data. For instance, the examples and characteristics of igneous, sedimentary, and metamorphic rocks were entered into a teacher-made database. The students then sorted and tabulated the data using the Filer. The writer, a simple text-editor, was used by the students to type reports, daily logs, and messages to others.

Although our data come from classrooms for the deaf, for whom spoken and written English can be difficult enough, we believe these problems are evident in many regular science classrooms. If we are correct, development of literacy skills must be made a more obvious part of the science curriculum. Further, we integrate important and interesting subjects such as science into the curriculum of students who are having trouble with literacy. There is no reason that deaf students must be deprived of science lessons because spoken and written English come slowly to them. The development of literacy skills should be moved from the hidden curriculum to the core of classroom science instruction.

The computer networked classroom also organizes interactions that are educationally productive. This is because the network highlights the literacy skills embedded in science lessons. Students must write everything down on the network. Thus there is extra time on task in both literacy and science. Our data indicate that the network also encourages children to attend to the various reading and writing devices they need in order to do the work. (Reich, C., Matthews, A., Brienne, D., Matthews, J., and Goldman, S. (1988). The pedagogical power of the network is that it allows for extended conversation among the children and adults on the network.

We are encouraged from our first overview of the data. The network seems to establish the social and conversational grounds for both literacy and science achievement. The children remain on task, and the tasks have become part of the fabric of the interactions among all of the members of the classroom.

Our data for identifying these links come from observations of over 75 science classes, interviews with teachers and students, videotapes of networked and non-networked science classrooms, written products of assignments, and a corpus of more than 2000 electronic mail messages generated on the network. We completed an analysis of electronic mail usage and functions, a descriptive analysis of over 1012 messages generated during the 1988 school year, and an analysis of patterns of interaction in networked and non-networked science classrooms. Each of these analyses contributed to our major conclusions.

Literacy Situated In Science Lessons

The networked science classroom provided a rich environment for literacy learning. We were struck by the fact that, in the course of their working with information and communicating about ideas, students' reading and writing increased substantially. We found the communications were related to the content and practice of science, and literacy skills overlapped in networked lessons.

From our field notes we can offer an example of literacy situated in science: students were working in a unit on rocks and minerals. After studying minerals, students were asked to identify 12 minerals by their specific characteristics. They used a minerals database on the Bank Street Filer program for the exercise. Each student was given a sheet of paper with "clues" to help them in the search for minerals. Each clue gave students a combination of information about the mineral that separated it from all other minerals. If students picked out the correct

information and used it to search the database correctly, they would identify the correct mineral. If students chose the wrong information from the clue, or if they constructed a "less than perfect" sentence for searching the database, they would not isolate the mineral they were looking for, but they would retrieve several mineral records. They could still find the mineral in that case, but they would have to browse through each record, skimming and matching their clues with information in the database. This way of completing the assignment was chosen by most students, though it did not necessarily make the task easier. The students used a variety of strategies for searching and browsing (e.g., completing all searches for minerals where a notation for hardness was given in a clue, then completing all searches where "silver" was a clue). The activity was literacy intensive, and students spent most of their time reading, constructing sentences and writing.

The students could read for specific information and write correct sentences or browse and skim - either way they increased their exposure to print.

Teacher Use of Electronic Mail

The decision to pursue a network was based in part on the idea that it would increase participation in written English. Electronic mail was used to carry on class discussions, complete assignments and other kinds of science writing tasks. Two ways the science teachers used this technology made student engagement with print an integral part of science learning activities.

The first teacher used electronic mail interactively with students as a review device for test preparation. This allowed the students to work independently and at their own pace and made a rapid individualized response from the teacher possible. The teacher remained the mediator of the students' progress towards goals that she prescribed. All students participated fully in the review exercise, an improvement over the typical pattern for face-to-face review discussions in deaf classrooms where only some of the students are involved. Students could also keep a record of the entire review and use that information to study.

The second teacher used electronic mail to present modifications of the state-mandated science texts to the students. She modified the language level of the text to students. The language level was modified to make the text more readable for students. The content remained unchanged. With the text and assignments on the network, she could better assess the students' understanding of science information and concepts. This was particularly important, because with this method, students were less hampered by written language and were able to complete three assignments in the same time they previously completed one. These results were impressive. The print environment increased productivity.

Analysis of Electronic Mail Writing

The messages from electronic mail were analyzed to describe the characteristics of the students' writing and to see if the network provided a forum for social interaction and science experiences. We found that the network provided opportunities for both. Students engaged in a variety of purposeful writing experiences about science. They wrote daily science logs, completed worksheets and assignments, reviewed for tests, typed homework, and had written conversational exchanges with their fellow students. Many of the activities featured dialogic interactions between students and teachers, such as responding to the teachers' questioning, recounting events, and creating event casts and stories. In their interactions, students used writing to make requests, negotiate behaviors, investigate, communicate information, express opinions, evaluate their own and others' classroom activities, accomplish social goals, and create fantasies. These kinds of interactions are present in the language development of hearing children and are especially created in many writing development programs (e.g., The Writer's Workshop which is used in the Lexington School).

The students used a variety of writing conventions and processes in these communications and often incorporated features of more experienced writers. One boy used the initiating vocabulary in his TOPIC sentence then used numbers to organize his responses which are shown here: (all examples are unedited)

> There are two ways that clastic rocks for are
> 1) from the pressure in the ocean or lakes.
> 2) the cement - when the minerals in ocean water stay behind while the water evaporates. The minerals glue the rock pieces together> (Colin)

Students tended to organize their responses by paragraphing, making lists, or utilizing "signal words" such as "first, net" to orient the reader. For example, one boy, organized his response to "List the 3 classes of sedimentary rocks and the sediments make up the rocks in each class," by using three paragraphs to correspond to the three classes:

> Clastic rocks formed inside ocean beds and any water bodies that from fragments of rocks became cement make two fragments of rocks together.
>
> Organic rocks formed on or inside crust that thousands years of fossils when dead plants and animals remain to broke into pieces of plants and animals. Also, inside water that sea animals died many years ago, their shells broke into pieces or remain on limestone's surface.

Chemical rocks formed near bay or coast that two minerals mixed into rock when in water, it float to shore, and rock was evaporation action. (Dennis)

One girl responded to "Describe the 2 ways that clastic rock can form" by using "2 ways" to organize her thoughts:

1 way underwater pressure the rock together
2 way there 3 different kind of rock like, calicat, halite and quartz stay in water when evaporate they became glue together (Karin)

The responses indicate that the students benefited from the interactive nature of these written lessons. The could elaborate on current skills, and model new skills they encountered in the writing of others.

For example, one boy responded to a Trivia Game Question,

"Why do you think some baseball players put black lines under their eyes when they're playing ball?"

the reason why the baseball player want the black stuff to put the eyes and it help the player to see the ball when it fly and it help to see better and it block the sun (Charles)

As the examples illustrate, the network provided opportunities for students to communicate about science through reading and writing and also provided a means for students to work with others as they tested new language skills.

Summary and Conclusion:

Our analyses revealed characteristics of a new kind of communication environment. The Literacy Network sufficiently enabled interactions in the science classrooms to make it a promising environment for the development of literacy skills in the long term. Teachers were able to obtain more reliable information about the location of language barriers that impeded both science learning and communication about general science concepts.

Our preliminary analyses of electronic mail indicated that students have complex thoughts and communicated them in many forms of writing--some in emergent stages. We believe the network makes possible an effective literacy environment for deaf children where reading and writing become a natural form of communication for both intellectual and social purposes.

Overall, we found that the system allows for flexibility in dealing with different levels of student ability. When there are widely ranging scholastic abilities within classes, as is the case in deaf education, this teaching approach can be of great value as it promotes independence. The teachers can cover a large amount of material individualized for each class and even for each student. We are beginning to see changes in writing samples and science grades are improving. Thus far, as a technology, networks can provide an additional channel for communicating in deaf classrooms.

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